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# EXTENSION WORK IN PLANT PATHOLOGY, 1923

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CONTENTS



## RELATION OF PLANT DISEASES TO CROP PRODUCTION

With the growth of our agriculture, new plant diseases are introduced and abundant opportunity is given for their development and dissemination. Extensive cultivation of any one crop in a region usually favors the increase of plant parasites. Frequently, by the time a crop reaches a place of importance in a community, the presence of one or more diseases has introduced an unwelcome element of uncertainty in plans for production.

Decreases of yield due to disease may be very serious and often bring the individual farmer face to face with a difficult economic problem (fig. 1). It is estimated that, in the case of six crops, the reduction in yield from disease during 1922 was as follows: Wheat, 83,795,000 bushels; cotton, 417,000 bales; corn, 187,524,000 bushels; potatoes, 120,943,000 bushels; apples, 59,120,000 bushels; and peaches, 13,068,000 bushels.[1] Because of higher prices obtained for the remainder, such reductions in yield may not result in corresponding reductions in the value of the total crop, yet they do represent actual losses to the individuals who suffered them.

[1] Supplement 30, The Plant Disease Reporter, Plant Disease Survey, U. S. Department of Agriculture.

8938—24——1

It is evident that uncontrolled reduction in yield due to the ravages of disease is one thing and a decrease in production due to a purposeful and intelligent limitation of acreage, which when planted is given proper protection, is quite another. In the first case we have uncertainty and waste of labor, land, and expenses incident to growing the crop; in the second case we have economy and some certainty of obtaining normal production.

Although the effect of some plant diseases is limited to reduction of yield in the field, other troubles not only cut production, but may cause blemishing of the fruit, either making it unmarketable or throwing it into a low grade. Nail-head spot of tomatoes,

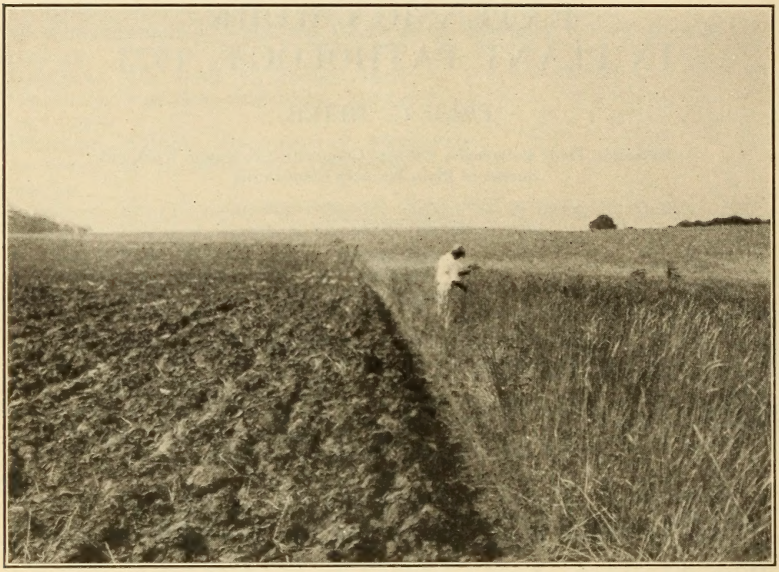

FIG. 1.—Decreases in yield due to disease may be very serious. Ninety acres of Marquis wheat which had to be plowed under, the field having been ruined by scab. (Reproduced from Farmers' Bulletin 1224.)

apple scab, and potato scab are examples (fig. 2). Still others, as brown-rot of peaches, potato late-blight, and sweet-potato black-rot, not only prevent the yield of part of the crop, but so affect the harvested product as to cause decay in storage and transit (fig. 3). To the wastage caused by this latter type must be added destruction by still another group of diseases, which, although of little or no importance in the field, may be responsible for extensive losses during the marketing period (fig. 4). For example, Rhizopus rot of sweet potato, though not recognized as a field disease, may be very destructive after harvest. Approximately 11,168,000 bushels of sweet potatoes rotted in storage during 1922 as a result of the action of plant diseases. In that same year the American railways paid claims on losses of fruits and vegetables in transit amounting to approximately $8,830,000. A great part of this sum, with its attendant expenditures for payment of the army of clerks and others necessary to handle the adjustments, represents losses in transit which were largely brought about by plant diseases.

Field, storage, and transit losses must be made up in part by increased market prices, so that the consumer shares with the farmer in payment of the annual toll exacted by disease.

## AIM OF EXTENSION WORK IN PLANT PATHOLOGY

Realization of this serious annual loss due to plant diseases has resulted in the growth of extension work in plant pathology. The aim of the work is to increase the efficiency of production, maintain high quality of plant products, and prevent wastage in storage, transit, and at the market.

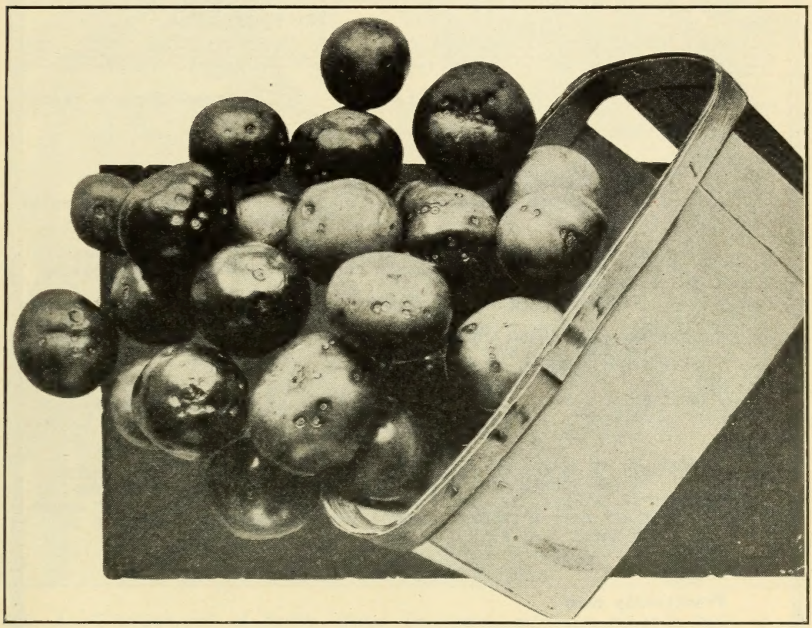

FIG. 2.—Nail-head spot of tomato often makes fruit unmarketable, or places it in a low grade. (From series prepared by Link and Gardner.)

## NATURE OF CONTROL MEASURES ADVOCATED

A study of the annual reports of extension agents shows that three main types of work enter into the plant-pathology extension program:

(1) Bringing into more universal use measures that have long been known to farmers in a general way, but which need urging to overcome the inertia which prevents general adoption. Sometimes such measures need modification to make them locally effective or within the means of the average man.

(2) Improvement of old control methods. As a result of the discovery of new facts through research work in plant pathlogy, control methods are constantly being improved. New information concerning the life history of the causal organisms may make this possible. More effective chemicals may be brought into use for treating soils or seeds or for the preparation of sprays. The development of new machinery sometimes makes a method more effective or easier of application, and perhaps puts it within the reach of more people.

(3) Introduction of entirely new control measures resulting from recent discoveries by research workers. Field and laboratory investigations here and there result in the discovery of fundamental facts concerning a disease,

which may bring about a complete change in the method of attack or, as is sometimes the case, may make it possible to devise a control measure where none had been known before.

F. P. I.—1
No. 844

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF MARKETS AND CROP ESTIMATES

ORIGINAL

FOOD PRODUCTS INSPECTION CERTIFICATE

This certificate is receivable in all Courts of the United States as prima facie evidence of the truth of the statements therein contained.

*Market* Pittsburgh, Pa. *Date* June 30, 1919 *Hour* 2:00 P.M.

*To* (Applicant.) *Address* Pittsburgh, Pa.

*Shipper* *Address* Fort Valley, Georgia.

*Receiver* *Address* Pittsburgh, Pa.

I certify that I am an agent of the United States Department of Agriculture, authorized to investigate and certify the quality and condition of food products under certain provisions, known as the food products inspection law, of an Act of Congress, approved March 3, 1921 (Public No. 267, 66th Congress), and the rules and regulations prescribed thereunder; that at the time and on the date stated above I inspected the following lot of food products received at the above market, an important central market designated by the Secretary of Agriculture, pursuant to said law and rules and regulations; and that the quality and condition, at said time and on said date, of such food products were as stated below:

*Car initials and number* *Kind of car* Refrigerator *Where inspected* Penna. Produce Yards

*Condition of car:* Vents closed. Ice plugs in. Bunkers full of ice. Doors closed but not sealed.

*Products inspected and distinguishing marks:* Peaches, 525 crates Hiley Belle variety, crates marked:- "Grown by _____, Fort Valley, Georgia"

*Condition of load and containers:* Intact. Crates loaded 4 high in five stacks near doorway, 5 high and 7 across in balance of car. Cross-stripped, leaving 1 to 4 inches between rows.

*Condition of pack:* Generally tight, and showing a slight bulge.

*Temperature of product:* 43° bottom and 52° fourth layer between doors; 55° fifth layer, center of end.

*Size:* Mostly medium size, and 2 x 2 pack.

*Maturity; Color:* Color good for the variety. Undecayed peaches generally soft in fourth and fifth layers, firm in the third and firm to hard in the two bottom layers.

*Decay:* AN AVERAGE OF 75 o/o SHOW DECAY FROM BROWN-ROT IN THE FIFTH LAYER, 50 o/o IN THE FOURTH LAYER, 15 o/o IN THE THIRD AND 5 o/o IN THE TWO BOTTOM LAYERS. THE AFFECTED PEACHES SHOW ONLY SMALL DECAY SPOTS IN THE THREE BOTTOM LAYERS, WHILE A FEW ARE COMPLETELY DECAYED IN THE FIFTH LAYER CRATES.

*Other blemishes and defects:*

Practically none.

*Summary—Quality; Condition; Grade:*

*Remarks:*

J. A. Marks
*Food Products Inspector.*

*Address* _____

PLEASE REFER TO THIS CERTIFICATE BY NUMBER AND MARKET

8—4383

FIG. 3.—Facsimile of a food-products inspection certificate, in which evidence is given of peach wastage caused by brown-rot during transit.

In most instances the extension worker deals with material that falls under the first and second headings. Most control methods now in use are subject to improvement. Some improvements come as the result of laboratory research, others with the advent of changes in

machinery and materials resulting from the interest of manufacturers, and still others as a result of practical experience of farmers and extension plant pathologists.

The fact that disease-control methods are not static makes it desirable for extension workers in this field to have the best of fundamental training in the life history of the fungi as well as in applied pathology, and such training is practically a necessity if new methods recommended by State, Federal, and industrial research workers are to be put into practice intelligently and advantage taken of every opportunity for progress.

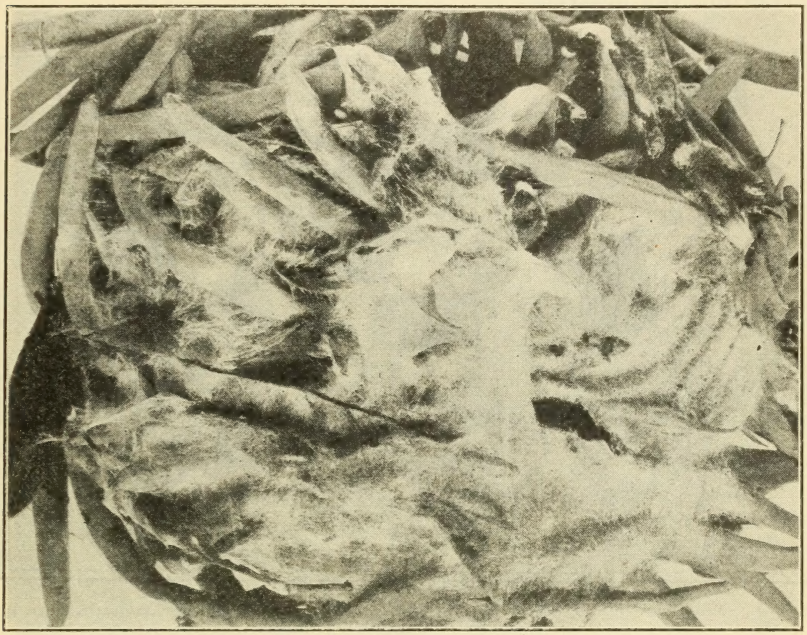

FIG. 4.—Rhizopus rot of beans. Some organisms, although causing little or no trouble in the field, may be responsible for extensive losses during marketing. (From series prepared by Link and Gardner.)

## LEADERSHIP OF EXTENSION SPECIALISTS

Although some extension work in plant pathology was carried on in practically all the States during 1923, 18 maintained approved Smith-Lever projects dealing with the subject (fig. 5). Twenty-seven pathologists, some of them working on part time, carried on the work in these States and this report deals largely with their activities. These men, cooperating with the State and Federal entomologists, horticulturists, and agronomists, help to form the group of specialists which serves as an auxiliary and directing force to the county agent system (fig. 6). By studying, with the aid of county agents, needs of farmers for plant-disease-control work, and by assisting in the development of county programs based on these needs, the extension pathologist multiplies his influence many times.

## EXTENSION CONFERENCES

An important conference of extension plant pathologists was held on December 31, 1923, at Cincinnati, on the occasion of the annual meeting of the American Phytopathological Society. This session was attended by 31 pathologists representing 15 States and the United States Department of Agriculture. The discussion by these specialists of results obtained and methods of conducting the work resulted in strengthening materially their State extension plans of work for the year following. This was the second annual conference of this type and proved to be so profitable that plans have been made to continue the practice.

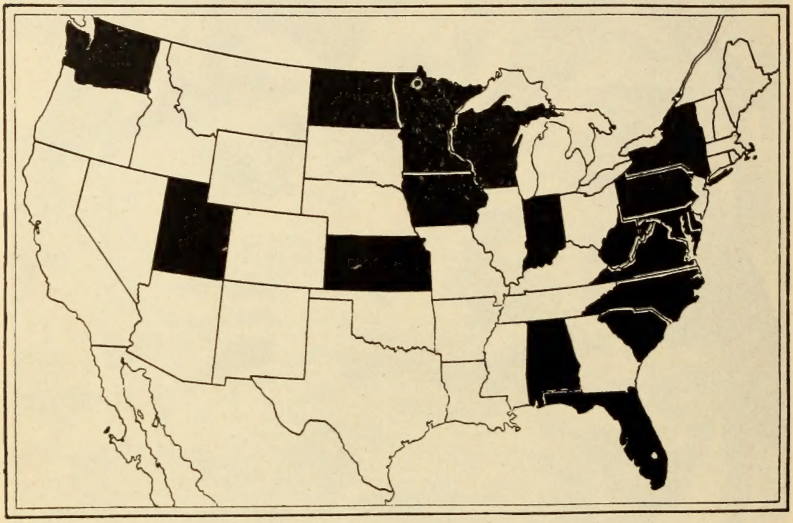

FIG. 5.—Map showing in black the 18 States that maintained extension projects in plant pathology during 1923.

## OUTSTANDING ACTIVITIES

### NATIONAL PROGRAM OF WORK

Demands for assistance by farmers led, in 1923, to the formulation of projects designed to reduce losses caused by more than 70 diseases affecting at least 30 crops [2].

Active work was as a rule preceded by plant-disease survey activity conducted in cooperation with the Plant-Disease Survey, United States Department of Agriculture. Depending on the nature of the disease these projects brought up extension problems arising from efforts to introduce or make more general such control measures as:

(1) Planting of immune or disease-resistant varieties.
(2) Crop rotation.
(3) Seed disinfection.
(4) Seed-bed sterilization.
(5) Field treatment of soil.
(6) Spraying and dusting.

[2] See table on page 20.

(7) Insect eradication to prevent transmission of disease.
(8) Selection of seed free from disease.
(9) Eradication of weeds and other plants that might harbor the causal organism.
(10) Careful handling and practice of sanitation during harvest.
(11) Proper storage and loading of cars.

While considerable time was given in some States to survey and eradication work in cooperation with the departmental and State agencies engaged in programs for control of white-pine blister rust and black stem rust of wheat, space does not permit a detailed discussion of these projects. Most of the extension effort was applied

FIG. 6.—County agent, extension plant pathologist, and extension horticulturist collecting the scab fungus on last year's apple leaves. By examining this material under the microscope information is obtained which helps to determine the proper time for spraying.

to four activities—introduction of resistant varieties, seed disinfection, spraying, and seed selection—which are discussed somewhat in detail in the following pages.

### PLANTING DISEASE-RESISTANT VARIETIES

In the field of control by use of disease-resistant varieties, work was reported in connection with the introduction of wilt-resistant strains of tomato, cotton, and cabbage, rust-resistant asparagus, root-rot resistant peas, root-rot resistant tobacco, and blight-resistant spinach.

G. W. Fant, extension plant pathologist of North Carolina, gave the following account of his work on cotton-wilt control:

In order to reduce the loss resulting from cotton wilt, demonstrations were arranged in the eastern portion of the State to show the most efficient method

for controlling this disease. Despite publicity given to cotton wilt and methods of control used in previous years, many farmers with infested fields are unfamiliar with the disease and the preventive measures necessary for its control. Demonstrations were held in Edgecombe, Lenoir, and Richmond Counties, which illustrated the control of the wilt trouble through the use of Dixie-Triumph wilt-resistant cotton. The yield from wilt-resistant cotton on 1-acre demonstration plots averaged approximately twice that of susceptible cotton on adjoining plots. These demonstrations have convinced the growers of the advisability of planting this cotton on infested areas, and as a result more extensive plantings of this variety will be made in 1924.

Generally, in territory where disease-resistant strains of plants could be used to advantage, it was not difficult to induce farmers to grow them. In such localities the work, for the most part, has passed beyond the demonstration stage and the problem is to establish a source of seed supply of a type to meet the local market requirements. This was accomplished through maintenance by the Department of Agriculture of a pure-seed stock of certain resistant varieties of tomatoes and asparagus, and in the case of cabbage by the Department of Agriculture and the University of Wisconsin. The departments of plant pathology in some States have developed strains of resistant plants which meet local requirements. This pure-seed stock was usually made available by the Government and States to reliable seedsmen for multiplication.

According to J. C. Walker, plant pathologist of the Bureau of Plant Industry, during 1922 and 1923, 3,200 pounds of wilt-resistant Wisconsin All Seasons cabbage seed were grown under supervision by the National Kraut-Packers' Association, and distributed to its members and to farmers outside of the association. The production of this seed stock was closely supervised by the Department of Agriculture, with the result that a check was kept on the degree of resistance of the plants.

Of the 1924 seed catalogues, more than 100 listed rust-resistant varieties of asparagus; more than 15, wilt-resistant cabbage; and more than 25, the wilt-resistant tomatoes developed by the department. An effort was made to keep county agents informed as to these sources of supply in order that they might furnish the information to farmers on request.

### SEED DISINFECTION

The number of diseases known to be carried on or within the seed of plants is constantly being increased. Since many of our economic plants fall in this group, projects on seed disinfection played an important part in the extension program. No attempt is made to cover the entire subject in this circular. Instead, reference is made only to a few activities which illustrate particular features of seed disinfection.

For some diseases, seed treatment combined with rotation to insure planting on disease-free soil is the only practical control measure known. Other diseases, when not distributed in a growing section, may be controlled by a cheap seed disinfection, making unnecessary the use of a spray which at best is only partially effective. For certain other troubles, seed treatment is but one of several means of control which are necessary to insure a satisfactory reduction of loss.

An interesting feature of this work was the way in which extension pathologists took advantage of the fact that most seed-treating operations can be centralized. It is obvious that if the work for a great many farmers is centralized at one plant, it not only can be done more economically but can be supervised more closely to insure accurate timing and correct preparation of chemicals or solutions used. Such treatment gives maximum control with a minimum of seed injury. Moreover, the enthusiasm that prevails when men are brought together to do such work can be taken advantage of, with the result that more farmers will treat their seed than if the work were done on individual farms.

In Indiana all farmers living in some communities were encouraged to treat their seed wheat by the hot-water method at a central station, thus establishing large smut-free areas and preventing spread of the disease by wind from fields planted with untreated seed to those near by where seed had been treated. Some threshers, to avoid the risk of contaminating their machines and making them dangerous for clean wheat, refused to thresh fields planted with untreated seed.

No small matter in obtaining general application of the method was the fact that community or other centralized treatment was usually more convenient for the individual, as well as less expensive and more effective. Community seed treatment of potatoes, as initiated by the extension pathologists of Wisconsin and Minnesota, is a good example of what can be accomplished in such work.

POTATO

In Wisconsin, where the cold corrosive-sublimate method was used, R. E. Vaughan, extension plant pathologist, has designed a large tank in which 40 to 70 bushels of potatoes can be treated at one time. Farmers and local merchants usually shared the expense of building such tanks, and the farmers contributed to the employment of an agent who, after being trained by the extension pathologist and the county agent, supervised the treatment. Treating stations are often located at the local creamery, where most farmers have business (fig. 7).

Cooperation of the creamery was of still greater importance in Minnesota, where the hot-formaldehyde treatment was used, for when the treating station was located at such a plant, steam for heating the solution could be obtained. Locating the treating station at the creamery made it possible for farmers to treat their seed potatoes immediately after unloading them from the freight car, so that the seed stock was taken to the farm ready for planting. Excellent work was done in Kansas, where E. A. Stokdyk, extension plant pathologist, demonstrated the effectiveness of seed treatment by the hot-formaldehyde method.

Following extension work with the hot corrosive-sublimate method in New York, some men took up potato-seed treatment as a commercial enterprise. Since farm labor was difficult to obtain in the spring farmers welcomed this development, as a result of which their seed stock could be treated on contract. When this system was used treatment cost about $1.20 an acre. The records for six years in New York show that potato-seed treatment has resulted in an average increase of 25 bushels to the acre.

TOBACCO

In Virginia contribution of funds by the Tobacco-Growers' Cooperative Association made it possible to employ for seven weeks an assistant whose time was spent on seed-treatment work in the department of plant pathology. Seed was sent in by farmers, and treatment and germination tests were made. The disinfected seed was then returned with a circular letter in which the growers' attention was called to the necessity for observing the additional precautions described under the headings, "Plantbed Sanitation" and "Field Sanitation," in a bulletin [3] which accompanied the letter.

FIG. 7.—Community seed treatment of potatoes at a Wisconsin creamery. County agents from 47 States reported that in 1923 treatment of seed potatoes was practiced on 39,629 farms.

CEREALS

The most conspicuous progress in the field of cereal-seed treatment was made in the State of Washington, where efforts to bring about the use of copper carbonate for control of cereal bunt were continued. This meant a change of practice for wheat growers from the inconvenient wet copper-lime and formaldehyde methods to the dust treatment. The work began in the spring of 1921, with ten 1-acre demonstrations. The practice spread in two years until 734,961 acres of the 1923 crop were sown with treated seed. This increase represented much hard work on the part of the extension pathologist and county agents. Farmers had difficulty in procuring the pure chemical, and it was necessary to increase the supply for the State. To make the work most effective, closed machines were used. Farmers either had to build a homemade affair or provision had to be made for commercial or cooperative treatment in large machines patterned after one that was developed by the college.

[3] Fromme, F. D., and Wingard, S. A., Blackfire and wildfire and their control. Va. Agr. Exp. Sta. Bul. 228, pp. 16 and 17. 1922.

After the seed was sown it was necessary to take records on a sufficiently large scale to convince growers who had not yet adopted the method that copper-carbonate treatment paid. During 1923 172 fields were examined in six counties. Records were taken on stand and the percentage of smut was determined in the case of grain grown from untreated seed and from seed that was treated with copper carbonate, formaldehyde, and bluestone. Records of this kind were brought to the attention of farmers. As a result of these activities it is estimated that approximately 1,500,000 acres of the 1923–24 wheat crop were sown with treated grain. Similar work is under way in other States where bunt is a serious factor.

#### SWEET POTATOES

Treatment of sweet-potato seed eliminated black-rot on certain Kansas farms and materially increased the yield per acre. In discussing this work, E. A. Stokdyk, extension plant pathologist, called attention to the fact that seed-treatment activity gave an avenue of approach for other lines of extension work.

#### CABBAGE

Seed treatment at the commercial seed house before distribution of cabbage seed stocks will probably become more common as time goes on. In New York three cabbage-seed producers were so strongly impressed with the results obtained by use of the hot-water method, as developed by cooperation between plant pathologists of the State and Federal Government, that they planned to treat most of the seed to be put on the market for 1924. If this practice could be made general, black-leg would be practically eliminated.

### SPRAYING AND DUSTING

#### RELATION OF EXTENSION WORK TO SPRAYING AND DUSTING

Farmers probably needed more assistance with spraying and dusting than with any other practice in disease control. This is due to the fact that if these measures are to be effective and profitable the fungicide must be prepared accurately and applied correctly within a definite and limited period, a period which depends on such matters as condition of fungous and insect pests, state of development of the plant, and variations in weather. The fact that conditions that influence the time of application and the choice of spray mixture to be used are likely to differ somewhat each season, necessitates constant watchfulness on the part of plant pathologists and entomologists to determine the appropriate sprays and the critical times for their application. In 1923, in order that farmers might have full benefit of such observations, the extension program was usually developed along the following lines:

(1) *Education of growers in fundamentals of disease control.*—This was an important feature of the work done by the extension pathologist in several States. E. C. Sherwood, extension plant pathologist of West Virginia, reported as follows:

> Addresses on plant diseases at general meetings were usually made in three sections. In the first section the nature and cause of plant diseases were explained in nontechnical language designed for the purpose. The difference between the cause of disease and its manifestation was brought out and

emphasis placed on the means of prevention rather than on cure. The main object was to lay the necessary groundwork for a more intelligent application of control measures recommended. * * * Next, some disease of general interest, such as tomato late-blight, was taken up from the standpoint of the life history of the causal agent and it was shown how the measures for its control are based upon the seasonal development of the fungus. Finally, the meeting was opened for questions and various local troubles were discussed in a practical way.

In Florida, instruction was given to growers at vegetable and citrus schools. E. L. Ayers, extension entomologist-pathologist, gave the following account of the citrus work:

More than 30 citrus schools were held during the year, with a total attendance of more than 1,500 citrus growers. Most of these schools were held in April and May, or early enough in the season for the grove owners and caretakers to follow instructions during the ensuing year in the control of citrus diseases and insects, particularly in the control of melanose and rust mite. These sessions ranged from a few hours to all day, and usually two or three lecturers were present. Microscopes, including binoculars, were carried along, and the growers were taught to recognize different diseases and insects. The meetings met with much enthusiasm wherever they were held, and in a number of sections the work was commended by resolutions and the desire expressed for other and more comprehensive meetings in the future.

(2) *Assistance to growers in selecting the kind of spray machinery best fitted to their needs.*—By discussing the fundamentals of spray work with commercial orchardists and the manufacturers of machinery, extension plant pathologists frequently were able to assist in developing a supply of machinery which was particularly suited to the crop and to the locality in which the work was to be done. In some States manufacturers were encouraged to exhibit spray machinery, so that farmers might become thoroughly familiar with the equipment that was on the market. Pioneer work was also done during the year by assisting in building stationary spray systems for large orchards.

It is the farmer with the small acreage who needs most guidance in selecting equipment. The initial cost of effective spray machinery often prevents the man who grows a small acreage of potatoes, or who has a few fruit trees, from giving such crops proper protection. Quantities of spray material and much good labor have been wasted by the use of inferior spray equipment, with the result that the farmer sometimes is worse off than if he made no effort to spray.

(3) *Spray rings.*—During 1923, a considerable advance was made in the solution of spraying problems by the introduction of plans for cooperative purchase and use of machinery by organizations consisting of several farmers with a common spray problem. The spray ring, by making possible economical use of the best high-power equipment, proved to be a means by which the grower with a small acreage might circumvent the obstacles which had formerly prevented successful control of disease, particularly if arrangements were made to employ an experienced spray man to make the applications for all members. Further development of spray rings will make possible profitable spraying of many crops which now are not being given proper care.

Increase in the use of combination equipment by farmers went hand in hand with the development of the spray ring. E. L. Nixon, extension plant pathologist of Pennsylvania, reported as follows:

The matter of reaching the small potato-grower in Pennsylvania with efficient spraying is made less difficult by the existence of a large number of so-called

farm orchards. The combination sprayers equipped with 4-horsepower engines or better, with pump of 10 gallons per minute capacity, are proving very satisfactory. They are readily converted from potato and truck sprayers to orchard sprayers merely by removing the spray boom and attaching a lead of hose and a spray gun. These machines are readily adaptable to other operations around the home, such as disinfecting and whitewashing farm buildings and fences. They are purchased and operated either by individuals or cooperatively by two, three, or four farmers. During 1923, combination sprayers served 396 farm orchards and as many potato patches in Pennsylvania.

(4) *Spray service.*—Under this heading comes such work as the giving of method demonstrations in spray mixing and mechanics of application; and the development of means for obtaining accurate information as to when spraying should be done and arranging for dissemination by mail, telephone, or radio, of this information when it is finally obtained.

IMPORTANT SPRAY PROJECTS

Some idea of the extent of spray operations influenced by extension forces can be gained by study of the diseases listed in the table on page 20. In general, extension activities led to spray work with more than 14 crops. The most noteworthy features of this work during 1923 were the continued development of the spray ring, increased use of the combination sprayer, and improvement of spray service to commercial and home orchardists. The major portion of the work done was in connection with projects on potato spraying, orchard spraying, and truck-crop spraying in the South.

POTATO SPRAYING

It has been found in many States that potato spraying results in increased yields even in years when late-blight does not occur and in sections where the disease is not prevalent. This is probably due in large measure to the fact that Bordeaux mixture is effective in reducing injury from leaf hoppers, flea beetles, and true tip-burn.

During 1923, in 10 of the 46 States reporting potato spray activities, extension plant pathologists conducted organized projects in this work. As an example of what may be accomplished in this field we have the work in Pennsylvania, which during 1923 was in its sixth year. The following summary indicates the part which the result demonstration has played in the development of potato spraying in Pennsylvania:

*Results of potato spraying in Pennsylvania, 1918–1923*

| Item | 1918 | 1919 | 1920 | 1921 | 1922 | 1923 |
|---|---|---|---|---|---|---|
| Number of counties conducting work | 12 | 26 | 46 | 57 | 63 | 63 |
| Number of demonstrations conducted | 32 | 224 | 318 | 402 | 447 | 220 |
| Number of acres sprayed | 314 | 1,787 | 6,192 | 10,140 | 16,680 | 23,000 |
| Average yield per acre sprayed—bushels | 142 | 169 | 258.3 | 233.5 | 220 | 257 |
| Average increase in yield per acre—do | 34.8 | 42.9 | 74.7 | 74.3 | 66 | 58 |
| Average per cent of increase | 32.2 | 34.2 | 41.0 | 47.7 | 44 | 30 |
| Average cost per acre | $8.26 | $10.85 | $10.56 | $11.03 | $10.34 | $11.00 |
| Average number of times sprayed | 5 | 5.5 | 6 | 6.5 | 6.8 | 7 |

Careful work by the extension pathologist of Pennsylvania led to installation of effective machinery on the larger farms and made possible the development of spray rings where good equipment could not otherwise be financed. In 1923, 220 spray rings reached 1,934

Pennsylvania farmers. Results of the spray work were gathered each year from widely distributed and accurately measured demonstrations, with adequate checks, and were made known to other growers in the State. Records of cost as well as yield were kept, and the Pennsylvania farmers have evidence that this practice is profitable.

ORCHARD SPRAYING

*Home-orchard spraying.*—Power equipment purchased for the use of spray rings for spraying potatoes made possible economical spraying of the few fruit trees growing around the farm home, which by themselves had not justified the purchase of power equipment. The type of combination sprayer described on page 13 did good service in Pennsylvania during 1923.

Where the potato crop or other plantings on the farm did not require attention, the spray ring proved profitable in treating the home orchard alone. W. S. Brock, the extension horticulturist of Illinois, reported as follows: "The problem of spraying the home orchard was handled by stimulating interest in the community power spray ring. In 1922 we reported that 35 such spray rings were in operation; in 1923 there were 49."

*Spray service to commercial orchardists.*—Orchardists in 14 States were assisted by the maintenance of some kind of spray service. These services were conducted in various ways, depending somewhat on the State extension organization. As a rule, this work involved cooperation between the departments of horticulture, entomology, and plant pathology of the State colleges. The plans used in New York, Virginia, and West Virginia are of interest because of the different methods of organization.

In New York the spray service is conducted under the supervision of two leaders, one from the department of plant pathology and one from the department of entomology. In reporting on this service for 1923, M. F. Barrus, extension plant pathologist, wrote as follows:

> Field assistants with good fundamental training in plant pathology and entomology are stationed in the counties as early in the spring as is necessary and continue therein during the growing period, which is usually six months. They have direct responsibility for the details of conducting the demonstration projects and for attending to such miscellaneous demands for information and assistance on the control of plant diseases and insect pests as their time will permit.
>
> The New York State College of Agriculture cooperates in this project by providing salary at the rate of $50 per month for the field assistant, who is appointed upon the recommendation of the leaders, subject to the approval of the farm bureau executive committee; by supplying him with the laboratory equipment needed for the proper and effective conduct of his work; and by giving him supervision through the leaders of this project or through other specialists whom they may assign to the work. These men, by visits and correspondence, continually aid the field assistant and check up his work. The county farm bureau organization cooperates by providing the field assistant with office room and facilities for office work, including telephone and telegraph expenses, and by allotting him space in the farm bureau news for news items. The county farm bureau organization also pays a part of the transportation of the field assistant to and from the State college at Ithaca not to exceed three times during the season on call for conference, the remainder of this expense being paid by the college; provides him with an automobile for full-time use within the county; maintains the car and pays all other necessary traveling expenses within the county when he is away from his headquarters; pays an additional salary of $100 or more per month; and gives such other

aid as is necessary for the proper prosecution of his work. The special work of the field assistant in such a county is to develop and maintain a spray information service. * * *

As one of the important duties of the field assistant is to decide upon the most suitable time for making application, as well as to provide a formula for the preparation of material used in spray or dust, it is necessary for him to have information, as accurate as possible, from day to day regarding the development of buds, flowers, and leaves of fruit trees in the different zones in the county; development of parasites and materials most effective in controlling them; and the probable weather conditions during the next few days. He obtains his information regarding development of trees and parasites from his own observations on trips about the county, and he is supposed to know the best means of controlling parasites. His information regarding weather is supplied him through cooperation with the office of the United States Weather Bureau at the college. The cooperation of the Weather Bureau is essential to the success of the spray information service. A special weather forecaster is appointed for this purpose by the bureau for April, May, and June, and long-range meteorological reports are sent directly to him. From these reports he prepares each night a special forecast, which is wired to the counties having special field assistants so as to reach them before midnight. Arrangements for the reception of the telegrams must be made by the farm bureau in each county. Basing his judgment upon the information he has received, the field assistant must decide what is the most opportune time for making an application.

In Virginia the orchard spray service was managed cooperatively by the departments of plant pathology, horticulture, and entomology. F. D. Fromme, plant pathologist, Agricultural Experiment Station, Blacksburg, Va., reported as follows:

A spray calendar is prepared and distributed in advance of the season. This contains advice as to the materials to be used, methods of preparation, and approximate time of application. Exact dates for spray applications, based on information received from field laboratory workers, are supplied to the orchardists during the growing season. The information is obtained from an entomologist and a pathologist located in a field laboratory at Winchester, from a research entomologist located at Leesburg, and from research men working at Crozet and Blacksburg.

In West Virginia, E. C. Sherwood, who handled extension work in entomology as well as plant pathology, directed the service personally. He established an office in the fruit-growing territory during the critical spring months, where he was able to observe conditions which had a bearing on spraying. Using the data obtained from such observations, he prepared and issued timely spray notices, which were printed in local papers and also mailed to all growers who desired them. With the assistance of the horticulturist and county agents field instruction was given to farmers in spray practice, improvement of equipment, and methods of spray mixing. This spray service was supplied on request to 300 growers whose combined holdings represented about 500,000 bearing trees.

### TRUCK-CROP SPRAYING

Active work was conducted in the Southern States in extending spray practice to truck crops. In South Carolina and Florida, initial demonstrations led to an increase in the spraying of the cucumber crop. Marked progress was made also in the watermelon spray program in South Carolina.

### SELECTING SEED FREE FROM DISEASE

The most important activities of extension workers in connection with seed selection were efforts to control the virus diseases of potato and the root, stalk, and ear rots of corn.

POTATO

The necessity for field inspection and selection of seed potatoes has been confirmed by investigations of the plant pathologists, who have brought to light the importance of disease as a factor in the deterioration of seed stocks. It has been found that "degeneration" of potatoes can be attributed largely to the presence in the field of various forms of the diseases known as mosaic, leaf-roll, and spindling tuber.

These so-called "degeneration" diseases of potato, if present in seed stock, may cause reductions in yield ranging from 15 to 70 per cent or even more. During the growing period aphids spread the diseases from infected to healthy plants, so that in a large field

FIG. 8.—A stop on a potato tour in New York to study diseases found in seed-source test plots. The well-planned tour has been a most effective agency for making farmers acquainted with the nature of plant diseases, their importance, and methods of control.

it is practically impossible to eliminate them by rogueing out the obviously diseased plants. Owing to the fact that tubers from infected plants produce diseased progeny the following year, it is evident that they should not be used for seed. It is somewhat difficult to avoid this, because, unlike such troubles as scab and rhizoctonia, the "degeneration" diseases can be recognized only by examining the growing plant.

From the extension point of view, the problem is twofold. It is necessary (1) to create among growers of table stock a recognition of what constitutes disease-free seed and impress them with the desirability of planting such seed, and (2) to develop among growers of seed stock methods of producing seed potatoes and bring such methods into sufficiently general use to supply the demand created by educational work among growers of table stock.

The more complete extension program includes the following:

| In seed-producing territory | In seed-consuming territory |
|---|---|
| (1) Searching for disease-free seed stocks.<br>(2) Development of isolated and closely rogued seed plats.<br>(3) Conducting field and bin inspections.<br>(4) Training inspectors.<br>(5) Demonstrating roguing.<br>(6) Conducting test plats of seed planted for certification.<br>(7) Teaching by means of farmers' tours and other agencies the methods necessary for production of disease-free seed. | (1) Conducting seed-source test plats.<br>(2) Inspecting seed-source test plats.<br>(3) Establishing record demonstrations.<br>(4) Teaching by means of farmers' tours and other agencies the value of disease-free seed (fig. 8). |

During 1923, 22 States reported projects in connection with potato-seed improvement. In Utah, the work was begun for the first time. B. L. Richards, associate professor of plant pathology at the agricultural college, reported as follows:

The year marked the first serious attempt at organized seed production and certification. On the whole, owing to the large number of factors involved, the results indicate a hopeful rather than a discouraging outlook. The work for 1923 points clearly to the fact that the problem of seed-potato production and the establishment of a definite industry in Utah is essentially an educational problem, and should be kept as an extension project to be definitely promoted and intensified.

Records kept by some of the States during the past few years show that yields have been increased by use of certified seed. M. F. Barrus, extension plant pathologist in New York, reported:

That good seed is being used more commonly than in the past, due to its availability and to the emphasis that has been placed upon it in extension work, is further shown by the higher average yield per acre for the State during the past five years than in previous years. A high average yield in any one year may be explained as due to favorable weather or absence of epiphytotic diseases or insects. But during the past five years there have been very dry seasons and very wet seasons, hot seasons and cold seasons, blight years and no-blight years, so that these factors can not have had more bearing on the average yield during the last half-decade than in the past. Yet never before, since records have been kept of the yield per acre of potatoes, have there been five consecutive years when the yield per acre each year has exceeded 100 bushels. The natural inference is that this must be due to the more general use of better seed. The possibility of even greater improvement is shown in the following table:

*Average yield of potatoes per acre in New York, 1916–1923*

| Item | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | 1923 |
|---|---|---|---|---|---|---|---|---|
| | *Bushels* | *Bushels* | *Bushels* | *Bushels* | *Bushels* | *Bushels* | *Bushels* | *Bushels* |
| Certified fields | 128 | 233 | 204 | 221 | 247 | 228 | 225 | 209 |
| All fields | 70 | 95 | 98 | 109 | 125 | 103 | 110 | 122 |

In Kansas, records of demonstrations showed that there was an average increase in yield of 40 bushels of potatoes to the acre, due to the use of certified seed; in New Hampshire, 63 bushels; in Ohio, 29.8 bushels; and in Delaware the increase in yield varied from 10 to 120 bushels.

CORN

It is estimated that in 1922, the root, stalk, and ear rots of corn caused reductions of yield amounting to 120,837,000 bushels. The re-

sults of field experiments show that losses due to these diseases can be materially lessened if farmers will give attention to the following: (1) Elimination of bad seed ears by means of germination tests, (2) practice of crop rotation, (3) preparation of the soil to insure its being in proper chemical and physical condition, (4) seed selection in the field before the first killing frost, and (5) proper curing and storing of seed corn.

Ten States reported extension work on control of corn root rot. The work in Virginia was of particular interest because of some of the agencies that assisted. Attention of farmers was first gained by conducting germination tests of seed-corn entries at a corn-utility show. Following this, arrangements were made to provide for com-

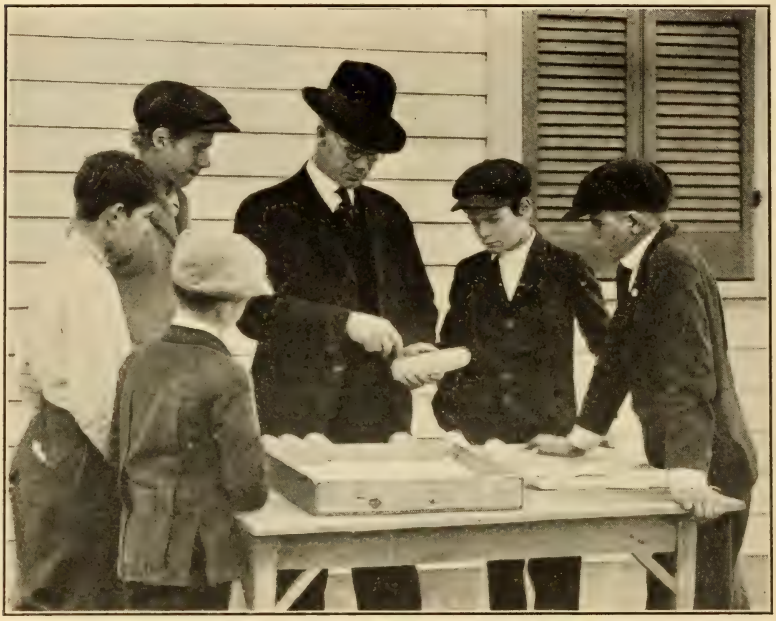

FIG. 9.—County agent instructing members of a boys' corn club in use of germinator.

munity testing of seed corn, and in this phase of the work two vocational schools gave assistance. Using plans supplied by the department of plant pathology, and acting under supervision of the extension pathologist, agricultural classes in these schools built large germinators, one of which had a capacity of about 4,000 ears. During the winter and spring months several lots of corn were run in these germinators.

Good work was done also by boys' corn clubs (fig. 9). A boys' club team gave demonstrations not only at the farmers' institute, but also at the Eastern States Exposition at Springfield, Mass.

In summing up the work, James Godkin, extension plant pathologist, stated: "A total of 5,690 ears of corn were tested, 54 per cent of which was found to be unfit for use as seed."

Donald Porter stated, in concluding a report of extension work in plant pathology in Iowa: "All investigations and demonstrations show that it pays to test each individual ear of corn and to discard all ears showing mold."

R. A. Jehle, extension plant pathologist of Maryland, said: "Certainly the demonstration work of 1922 and of the present year (1923) has demonstrated that it is well worth while for any farmer to give careful attention to this (the germination test) in the selection of his seed corn and not use for seed any ears which show marked signs of the disease."

## RESULTS

The foregoing brief account, touching as it does on but a few of the many instances of good work reported throughout the year, may serve to give some idea of the national program for control of plant diseases. It is evident that in some localities certain crops and dependent industries could not have been profitably continued without this assistance. The annual reports of county agents gave some idea of the extent of the control operations that were brought about as a result of the influence of extension work during 1923. This information is summarized in the table on page 20.

## CONCLUSION

After studying accomplishments in the several States during 1923, one is impressed with the fact that real progress was made not only in proving the value of certain practices, but in developing extension methods for calling these practices to the attention of farmers in such a way as to bring about their adoption.

Successful use of copper-carbonate dust for controlling covered smut of wheat; increased yields obtained as a result of teaching farmers the value of disease-free potato seed; confirmation of the fact that potato spraying pays in many sections even in the absence of late-blight; successful commercial use by farmers of disease-resistant varieties of asparagus, cabbage, tomato, and other plants; all of these brought additions to knowledge from the subject-matter point of view.

Noteworthy efforts were made in the field of extension methods; such as the building up of systems for spray information services; the development of means for obtaining wholesale treatment of seed by dealers; arrangements for maintaining disease-resistant stocks of certain seeds, either by cooperation with seedsmen or by means of seed-increase plots at the college; and the perfecting of plans for training farmers in the fundamentals of plant-disease control. Throughout all this work there was a growing realization of the necessity for cooperation with extension specialists in other lines and maintenance of close contact with research workers.

The opportunities for work in this field were never so great as at present. Increased cost of labor and other items connected with production, the practice of selling many plant products according to grades which are based in part on degree of freedom from disease, and the prevailing high freight rates make desirable the efficient production of high-grade products that can be transported without excessive wastage. More general application of disease-control measures is one of the necessary steps by which this result can be obtained.

## APPENDIX

*Accomplishments for 1923, as indicated by reports of county extension agents*

| Item | Number of States reporting | Number of agents reporting | Number of farms |
|---|---|---|---|
| Farms treating seed wheat for smut | 38 | 562 | 37,443 |
| Farms treating seed oats for smut | 43 | 597 | 40,475 |
| Farms treating barley seed for smut | 31 | 110 | 1,757 |
| Farms planting improved or certified potato seed | 47 | 1,032 | 60,065 |
| Farms treating potato seed for disease | 47 | 892 | 39,629 |
| Farms planting improved or certified sweet-potato seed | 23 | 289 | 8,450 |
| Farms growing improved or certified sweet-potato seed for sale | 20 | 195 | 1,837 |
| Farms treating sweet-potato seed for disease | 22 | 248 | 5,117 |
| Farms treating cotton seed for disease | 13 | 45 | 2,128 |
| Farms treating tobacco seed for disease | 11 | 52 | 2,917 |
| Farms treating other seed for disease | 8 | 11 | 390 |
| Farms spraying or otherwise treating tree fruits for disease and insect pests | 48 | 1,453 | 80,884 |
| Farms spraying or otherwise treating bush and small fruits for disease and insect pests | 42 | 332 | 10,112 |
| Farms spraying or otherwise treating grapes for disease and insect pests | 38 | 388 | 10,619 |
| Farms spraying or otherwise treating market gardening, truck, and canning crops for disease and insect pests | 39 | 404 | 13,579 |
| Farms spraying or otherwise treating vegetable gardens for disease and insect pests | 42 | 494 | 24,548 |
| Farms spraying or otherwise treating flowers and shrubs for disease and insect pests | 40 | 252 | 6,810 |

*Some diseases included in projects of extension workers for 1923*

| Crop | Disease |
|---|---|
| Apple | Anthracnose. |
| | Bitter-rot. |
| | Black-rot. |
| | Blotch. |
| | Cedar rust. |
| | Crown-gall. |
| | Fire-blight. |
| | Scab. |
| | Sooty blotch. |
| Asparagus | Rust. |
| Barley | Covered-smut. |
| | Loose-smut. |
| | Stripe. |
| Cabbage | Black-leg. |
| | Black-rot. |
| | Yellows. |
| Cantaloupe | Anthracnose. |
| | Blight. |
| | Downy mildew. |
| Celery | Early-blight. |
| | Late-blight. |
| Cherry | Leaf-spot. |
| Corn | Root, stalk, and ear rots. |
| Cotton | Anthracnose. |
| | Wilt. |
| Cucumber | Angular leaf-spot. |
| | Bacterial wilt. |
| | Downy mildew. |
| Grape | Black-rot. |
| Grapefruit | Citrus scab. |
| | Melanose. |
| | Stem-end rot. |
| Lemon | Shell-bark. |
| Oats | Crown rust. |
| | Smut. |
| Onion | Smut. |
| Orange | Blast. |
| | Citrus scab. |
| | Crown-gall. |
| | Melanose. |
| | Melaxuma. |
| | Scaly bark. |
| | Stem-end rot. |
| Pea | Root-rot. |
| Peach | Bacterial shot-hole. |
| | Brown-rot. |
| | Leaf-curl. |
| | Nematodes. |
| Pear | Blight. |
| Pecan | Rosette. |
| | Scab. |
| Potato | Black-leg. |
| | Early-blight. |
| | Late-blight. |
| | Leaf-roll. |
| | Mosaic. |
| | Rhizoctonia. |
| | Scab. |
| | Spindling tuber. |
| | Wart. |
| Raspberry | Anthracnose. |
| | Cane-blight. |
| | Crown-gall. |
| | Eastern bluestem. |
| | Leaf-curl. |
| | Yellows. |
| Rose | Black-spot. |
| | Powdery mildew. |
| Sorghum | Kernel smut. |
| Spinach | Blight. |
| Sweet potato | Black-rot. |
| | Scurf. |
| | Storage rots. |
| | Wilt. |
| Tobacco | Angular spot. |
| | Root-rot. |
| | Wildfire. |
| Tomato | Early-blight. |
| | Late-blight. |
| | Leaf-spot. |
| | Wilt. |
| Watermelon | Anthracnose. |
| | Stem-end rot. |
| Wheat | Covered smut. |
| | Loose-smut. |
| | Stem-rust. |



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